CLAIMS

What is claimed is:

Claim 1 - A semi-closed Brayton cycle power generation system, comprising in combination:

a gas compressor having an inlet and an outlet;

a combustor downstream of said compressor, said combustor having a fuel port coupled to a source of fuel, an oxidizer port coupled to said compressor outlet and an outlet port for combustion products resulting from combustion of fuel from said source of fuel with oxidizer from said oxidizer port;

a turbine downstream of said combustor, said turbine having an input coupled to said combustor outlet port, an output for the combustion products entering said turbine at said input, and a power output;

a return duct downstream of said turbine, said return duct receiving at least a portion of the combustion products passing through said output of said turbine and extending to said inlet of said compressor;

a gaseous oxygen duct coupled to a source of oxygen and coupled to said return duct in a manner adding oxygen to the combustion products within said return duct; and

said gaseous oxygen duct located upstream of said gas compressor, such that at least a portion of the oxygen from said gaseous oxygen duct enters said compressor inlet along with the combustion products.

Claim 2 - The system of Claim 1 wherein an air inlet duct is coupled to said return duct at a location upstream of said gas compressor.

Claim 3 - The system of Claim 2 wherein said air inlet duct has a valve thereon said valve capable of selectively opening and closing said air inlet duct.

Claim 4 - The system of Claim 3 wherein an outlet duct is located downstream of said turbine output, said outlet duct leading out of said system, such that when said air

inlet duct is open and said outlet duct is open, said system can operate as an open Brayton cycle power generation system.

Claim 5 - The system of Claim 4 wherein a valve is located on said outlet duct.

Claim 6 - The system of Claim 5 wherein a heat recovery steam generator is located downstream of said turbine output, said heat recovery steam generator transferring heat out of the combustion products exiting said turbine output, said outlet duct located upstream of said heat recovery steam generator and downstream of said turbine output.

Claim 7 - The system of Claim 5 wherein a heat recovery steam generator is located downstream of said turbine output, said heat recovery steam generator transferring heat out of the combustion products exiting said turbine output, said outlet duct located downstream of said heat recovery steam generator.

Claim 8 - A method for starting a semi-closed Brayton cycle power system including the steps of:

providing a semi-closed Brayton cycle power generation system including:

a gas compressor having an inlet and an outlet;

a combustor downstream of the compressor, the combustor having a fuel port coupled to a source of fuel, an oxidizer port coupled to the compressor outlet and an outlet port for combustion products resulting from combustion of fuel from the source of fuel with oxidizer from the oxidizer port;

a turbine downstream of the combustor, the turbine having an input coupled to the combustor outlet port, an output for the combustion products entering the turbine at the input, and a power output;

a return duct downstream of the turbine, the return duct receiving at least a portion of the combustion products passing through the output of the turbine and extending to the inlet of the compressor;

a gaseous oxygen duct coupled to a source of oxygen and coupled to the return duct in a manner adding oxygen to the combustion products within the return

duct;

the gaseous oxygen duct located upstream of the gas compressor, such that at least a portion of the oxygen from the gaseous oxygen duct enters the compressor inlet along with the combustion products; and

wherein an air inlet duct is coupled to the return duct at a location upstream of the gas compressor;

opening the air inlet duct so that air can pass into the return duct upstream of the compressor inlet;

keeping the oxygen duct initially closed;

starting the combustor, the turbine and the compressor of the semi-closed Brayton cycle power generation system;

opening the oxygen duct; and

closing the air inlet duct.

Claim 9 - The method of Claim 8 including the further step of removing a nitrogen constituent of air entering the system at the air inlet duct during said opening step by including a divider downstream of the turbine output, the divider leading a portion of an exhaust from the turbine to a separation duct leading away from the inlet of the compressor, and allowing the nitrogen to gradually separate out of the system through the separation duct.

Claim 10 - The method of Claim 8 including the further step of providing an outlet duct, opening the outlet duct before said starting step; and

closing the outlet duct after said starting step.

Claim 11 - A semi-closed Brayton cycle power generation system, comprising in combination:

a gas compressor having an inlet and an outlet;

a combustor downstream of said compressor, said combustor having a fuel port coupled to a source of fuel, an oxidizer port coupled to said compressor outlet and an

outlet port for combustion products resulting from combustion of fuel from said source of fuel with oxidizer from said oxidizer port;

a turbine downstream of said combustor, said turbine having an input coupled to said combustor outlet port, an output for the combustion products entering said turbine at said input, and a power output;

a return duct downstream of said turbine, said return duct receiving at least a portion of the combustion products passing through said output of said turbine and extending to said inlet of said compressor;

a gaseous oxygen duct coupled to a source of oxygen and coupled to said return duct in a manner adding oxygen to the combustion products within said return duct;

said gaseous oxygen duct located upstream of said gas compressor, such that at least a portion of the oxygen from said gaseous oxygen duct enters said compressor inlet along with the combustion products;

said source of oxygen including an ion transfer membrane between an air inlet and an oxygen outlet, said oxygen outlet coupled to said gaseous oxygen duct; and

an air heater between said air inlet and said membrane, said heater transferring heat from the combustion products downstream of said combustor into the air entering said air inlet.

Claim 12 - The system of Claim 11 wherein a diversion line is located downstream of said turbine output, said diversion line directing combustion products to said heater between said air inlet and said membrane.

Claim 13 - The system of Claim 11 wherein a heat recovery steam generator is located downstream of said turbine output, said heat recovery steam generator removing heat from the combustion products exiting said turbine output, said heat recovery steam generator heating water upstream of a steam turbine; and

a diversion line diverting water between said heat recovery steam generator and said steam turbine to said heater between said air inlet and said membrane before said

diversion line returns to said steam turbine.

Claim 14 - The system of Claim 11 wherein a heat recovery steam generator is located downstream of said turbine output, said heat recovery steam generator removing heat from the combustion products exiting said turbine output, said heat recovery steam generator heating water upstream of a steam turbine; and

a diversion line extending from a location midway between an inlet of said steam turbine and an outlet of said steam turbine, said diversion line routed to said air heater between said air inlet and said membrane before said diversion line returns to said steam turbine.

Claim 15 - The system of Claim 11 wherein a partial condenser is located downstream of said turbine, said partial condenser including a condensate line for removal of condensed water out of said partial condenser, said condensation line routed to said combustor along a path bypassing said compressor, said path including a water preheater there along, said water preheater receiving heat from nitrogen discharged from said source of oxygen.

Claim 16 - The system of Claim 15 wherein said condensate line includes a second preheater receiving heat from oxygen discharged from said oxygen outlet of said source of oxygen between said membrane and said gaseous oxygen duct.

Claim 17 - The system of Claim 11 wherein a heat recovery steam generator is located downstream of said turbine output, said heat recovery steam generator removing heat from combustion products exiting said turbine output and adding heat to a bottoming cycle working fluid upstream of a bottoming cycle turbine, a diversion line downstream of said bottoming cycle turbine including a preheater thereon, said preheater heating the bottoming cycle working fluid with heat from hot gases exiting said source of oxygen before said bottoming cycle working fluid is routed back to said heat recovery steam generator.

Claim 18 - The system of Claim 11 including a heat recovery steam generator

downstream of said turbine output, said heat recovery steam generator transferring heat from the combustion products exiting said turbine output to water in a bottoming cycle coupled to said heat recovery steam generator, said bottoming cycle including a gas generator having an oxygen inlet, a hydrocarbon fuel inlet and a water inlet, said water inlet coupled to said heat recovery steam generator to receive water from said heat recovery steam generator, said gas generator combusting said hydrocarbon fuel with said oxygen to produce combustion products including carbon dioxide and water, said bottoming cycle including an expander downstream of said gas generator and a condenser downstream of said expander, said condenser separating at least a portion of the water in the combustion products from a portion of the carbon dioxide in the combustion products, at least a portion of the water in the combustion products recirculated to said heat recovery steam generator.

Claim 19 - The system of Claim 18 wherein a compressor is located downstream of a gas outlet of said condenser, said compressor configured to compress gases including CO_2 passing therethrough to sufficient pressure to allow injection of the gases including CO_2 into a terrestrial formation for elimination of the CO_2 from atmospheric release.

Claim 20 - The system of Claim 19 wherein said oxygen inlet of said gas generator is coupled to said oxygen outlet of said source of oxygen and wherein said source of oxygen includes a hot nitrogen outlet, and a heat exchanger between said hot nitrogen outlet and a condensate outlet of said condenser of said bottoming cycle, such that condensate from said condenser including water is preheated with heat from hot nitrogen exiting said source of oxygen.

Claim 21 - The system of Claim 20 wherein a heat exchanger is interposed between said air inlet and said membrane of said source of oxygen, said heat exchanger receiving heat from combustion products downstream of said gas generator of said bottoming cycle, the combustion products routed past said heat exchanger in heat transfer relationship with air between said air inlet and said membrane.